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Image Processing in Forensics (Blood Spattering, Histogram Based Contrast Enhancement, Detection of Near Duplicate Images)

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Abstract: The application of image processing laboratories of crime investigating include the use of electronic screening devices that can put a check on the aberrations in the picture and also help in the collection of important piece of information and critical details that are hidden from normal observations and also aid towards providing acute and clear images. Various professionals utilize this technique of treating images for studying of the offensive situations.The primary aim of the responsible person for data analysis in these situations is to discover the processes that will contribute towards the best data to be drawn out from the research of acquired pictures. Some of the techniques upon which we have worked on include near duplicate image detection, histogram based contrast enhancement and blood spatter analysis. Approximately identical image identification basically aims at detecting the crime of falsely making or copying a document in order to deceive people.The technique of improving the contrast aims to discard the challenges that hinder proper collection of data in order to get better images with improved appearance and information. Blood spatter analysis involves the use of spontaneous and easily available options that can be used in the event of crime to study individual blood spots. This paper deals with the detailed study of these three techniques.

Keywords: Electronic screening device ,Blood Spatter, identical image,histogram.

INTRODUCTION

In [13], approximately identical image identification basically aims at detecting the crime of falsely making or copying a document in order to deceive people. This technique basically encompasses all those crimes wherein a portion of the image is imitated or duplicated in some other part of the same image. Various authors have worked on this technique and have introduced several evolutionary ideas and applications that have greatly enhanced and widened its applications in the area of forensics. Identification of such regions imply illegal interference. Due to lossy compression resulting from the use of JPEG, or due to the use of certain applications, the regions that are duplicated are not identical in most of the cases. The detection technique involves many steps which include generalization of image with the blocks that lie over it, presentation of unique attributes and also corresponding those blocks. The exact explanation for approximately identical images change greatly depending on intensity of light, configurational changes. We apply this term for images that are identical with respect to certain viewpoints but cannot be recognized to be identical due to skillful doctoring of those images. Blood samples are the most common evidences in the event of a crime. Crime investigators collect the information from these samples in order to identify various circumstances that led to the crime. Blood spattering techniques involve crude analysis of the samples so collected using sophisticated techniques. Different methods are used to collect the samples which include sophisticated and costly cameras, dissection tools, drawing and sketching materials etc. The works that various authors have done in this field include the use of 3D scanning technology to record the crime scenes, automatic technology for calculating the impact angle of spatter, quantitative analysis of high blood stain pattern by image processing, work developed by simple image processing method for calculating impact angle of stain. Contrast enhancement is a very important part of image processing and has several applications in forensics as well. Using contrast enhancement we can enhance an image which has unclear details about a forensically important scene or picture such as one in which we can see the face of the criminal but due to poor contrast are unable to identify the exact person. There are two types of contrast enhancement methods, direct and indirect out of which we have chosen histogram equalization which is an indirect contrast enhancement method as the method for contrast enhancement in our paper. Histogram based contrast enhancement works on the principle of plotting the image histogram and then performing several modifications (such as flattening the histogram and stretching the dynamic range of gray levels) on the histogram to enhance the contrast of the image. Histogram enhancement is a very simple and efficient method of contrast enhancement therefore it is widely used.

REVIEW AND RESULT:

NEAR-DUPLICATE IMAGE DETECTION:

In [1], the authors have addressed the issues of corresponding, screening and gaining knowledge about patterns to use the advantages of core points for approximately identical image identification. They have mainly studied two tasks i.e recovery and discovery of such points, in these aspects. In recovery, the keyframes from the queries are pulled to higher areas of an arranged list so as to identify them rapidly. In discovery, a decision to select one out of two keyframes is made. We can then gain knowledge about the patterns so formed for discovery. In identical pairs, points can be indentified over certain arrangements in space. These patterns that match can be used for precise detection. This paper contributes to: corresponding, screening and gaining knowledge about patterns. In corresponding, symmetric matching based on one to one point is done to force the closest point in set matching. In this technique, each point of interest can pair with maximum one point such that the points in each pair are the closest to each other. This technique has the advantage that only the most dependable pairs are matched so that unclear and vague matches cannot pass through true patterns. In Screening, a structure having several dimensions of indexes, is put forward for the fast sieving of

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descriptors for matching. A competent collision function is infused to improve the likelihood of indentifying a closest neighbour quickly. The data distribution of the components are found out, then the maximum and minimum likelihood of intersecting a resembling pair can be found to showcase the efficiency of this technique. In gaining knowledge, the matching patterns are captured in a histogram and then learnt using support vector machines. One advantage of this method is that point based features are effectively superior to the other retrieval techniques and does not have language barrier and is more direct than other techniques. The speed of this technique is the only shortcoming as a result of which it cannot efficiently handle thousands of points.

Zhao et al. in [2], have developed an interestingly new assessment technique for patterns which can identify the consistency of patterns in space formed by the localised points. More specifically, the logical interconnection of patterns and interpretation of visual resemblance, where there could possibly be many duplicate areas that have underwent haphazard transformations respectively, are properly looked after through the extent of entropy .A real time structure made of three parts: multiset representation of words, confined core points matching , is proposed for fast identification of approximately identical images. An unusual approach is put forward to ascertain the approximate identical parts by examining the identical patterns formed by two sets of points. The patterns formed by identical pairs logically follows a normal pattern and are free from unevenness under some unfamiliar transformations , compared to those patterns that are formed by haphazard matching. The major contributions of our work include: corresponding pattern and fast screening. In corresponding, the consistent relation of patterns formed by core points matching of approximately identical images are explored. An interesting measure, which considers scaling and rotation effects, is put forward for recording the solitary corresponding patterns. This method focuses on the changes of the approximate identical areas in images, giving a powerful algorithm even when various regions are separately identical. In fast screening, a detection algorithm having two stages is proposed which utilizes a multiset of words for fast sieving in the very first level. Only few candidates are saved for investigation in the later stages using matching and taking into account their scaling and rotation effects. This scheme fastens the detection by several hundred times without any visible reduction in performance. This technique has the advantage of performing better than other existing measures and also hastens the detection radically. But a comprehensive search of all points is required to find the best match and this is slow for large databases. These are its only shortcomings.

In [3] the authors have presented a resemblance measure based on parts of images derived from random probability distribution analysis and correspondence of graphs relating the inherent qualities that project the parts that an image scene is related to or is composed of. This model is primarily distinct from other existing approaches having low level characteristics or image positioning. The usefulness of this approach lies in the fact that it is able to adjust relations of inherent qualities in space and also tolerate observed and unobserved learning from facts and statistics. Several experiments are performed to compare the present approach to prior approaches and found that this approach outperforms several others. A part of the image is represented by graphs relating the inherent qualities that project the parts that an image scene is related to or is composed of. The likelihood model is derived from the similarity ratio of the transformation process that converts one graph to another. Such a model provides us an important structure for calculating and analyzing the likelihood and enables us to measure the similarity from the facts in both guided and unguided fashion. For matching two images, this model transforms a scene to adjust the changes of the two approximate identical images which includes the act of moving of objects, blockages and also the emergence of new objects. The computation of the similarity ratio is achieved through the use of an algorithm which is developed to fasten the similarity computation. The likelihood model is learnt in the apex position in a guided fashion and visually in an unguided fashion by choosing the best prospect. This is the first mathematical structure that can adjust varieties of image identical points .This technique is also general as more and more features of image can easily be used. The advantage of this technique is that other parameter settings does not affect it and is performance is very little affected by camera models. One shortcoming of this technique is that with the increase in the number of core sensitive points, its performance degrades.

In [4] the authors have proposed a method for approximately identical identification and hidden image recovery. This technique is applicable for detecting copyright breaches and finding false images. Approximately identical images are defined as images that are changed or varied with known changes. This system constructs a part by part representation of images using distinguishing local characteristic feature which provides efficient matches even under acute changes. In order to cope up with a variety of extensive features drawn out of the images, a technique used to map input items so that similar items map to same buckets with high probability , is applied in order to fetch the local characteristic features. This thereby enables us to make close alikeness doubts that only inspects a small part of the dataset. Although the technique of mapping input items so that similar items map to same buckets with high probability has excellent abstract performance properties, a benchmark application would still be unacceptably slow for this application. It shows that, by making an effective layout and indexing resources on disk, it is possible to efficiently fetch the indices having many such points. Fetching times are designed to respond even for assemblage of millions of images. Advantage of this technique is that it is favorably unaffected to common transformations. One shortcoming is that this technique can find identical points on landmarks and match them.

HISTOGRAM BASED CONTRAST ENHANCEMENT:

Stark et. al., in [5] spatial smoothing, cumulation and weighting functions have been used to map input grey levels to output grey levels. Combinations of different window widths (α) and contrast effect parameters(β) are used to get different contrast images which have been demonstrated in the presentation. Window width is varied and the different contrast effect parameter values are assigned to get the different contrast images. The advantage of this algorithm is that by varying one or two parameters, the

resulting algorithm can produce a varied amount of contrast enhancement, at one end leaving the image unchanged and at another end producing full adaptive equalization. On the other hand the disadvantages are that the extent to which the character of the image is changed is undesirable for many applications. Also, it uses a single global contrast enhancement to map input grey levels to output gray levels, thus it cannot be used to enhance the local contrast.

T.Arici et. al., in [6] firstly histogram smoothing is used to smooth(equalize) the histogram secondly, it uses weighted histogram approximation and thirdly black and white stretching has been used to remove the spikes in the histogram. Then an algorithm which has low complexity has been suggested for enhancing the contrast which is further compared with traditional HE(Histogram Equalization) and WTHE(Weighted Threshold Histogram Equalization). The advantages of this algorithm is firstly, the contrast of the image/ video can be enhanced without incurring visual artifacts that reduce the visual quality of an image and cause the image/video to have an unnatural look. Secondly, the proposed algorithm avoids complex and time-consuming calculations and also avoids operations that consume greater memory bandwidth in order to obtain a real-time implementable algorithm. Thirdly, the images which are obtained by applying this algorithm are aesthetically pleasing, artifact free, and also looking have a natural look. Fourthly, it does not introduce flickering, which is vital for video applications. Finally, the proposed method is applicable to a wide variety of images and video sequences. It also provides a level of controllability and adaptivity through which varied levels of improvement of contrast, from histogram equalization to no contrast enhancement, can be achieved. The shortcoming of this method is that the complication in time of the suggested method is slightly worse than the classical method to equalize the histogram as in latter we do not modify the histogram before performing equalization.

In [7], the authors have proposed an algorithm which divides the histogram of the image into several sub-histograms until it makes sure that no portion which is dominating is present in any of the sub-histograms which are now created. Then a gray level(GL) range which is dynamic is allocated for each sub-histogram so that the mapping of the gray levels can be performed on it by HE. This is done by distributing the total dynamic range of gray levels that are available, among the sub-histograms based on their dynamic range in the image which is input and cumulative distribution function of histogram values. Distributing the contrast in such a way prevents small attributes of the image which is entered from being dominated and washed out, and guarantees an average enhancement of the contrast of each part of the entire image. Lastly, for each sub-histogram a transformation function is computed individually based on the classical HE method and gray levels of input image are mapped to their respective output image. It also has several advantages which are first it improves the contrast of an image without losing any detail of it. Second, this method beats other present methods by better improving the contrast without incurring extreme side effects, such as washed out look, checkerboard effects etc., or undesirable artifacts. Third, the algorithm is simple and computationally effective that makes it simple to implement and use in real time systems. Its shortcoming is that computationally complex from the point of view of implementation.

Kim et. al in [8] have proposed a new contrast enhancement algorithm is proposed. The most important feature of this algorithm is a low-pass filter shaped mask. This mask is used to obtain a probability density function of sub-region. The size of the mask can be changed along a range to achieve improvement in the quality. But such improvement takes place at the expense of increased complication in calculation. The benefits of this algorithm are firstly the powerful contrast enhancement capability of the algorithm is useful in many consumer electronics fields, such as commercial recording instruments, digital static cameras, and especially closed-circuit cameras. Second, due to its simplicity, the algorithm can be implemented in simple hardware and processed in real-time. The disadvantages of this algorithm are, it incurs extra costs due to the use of masks as well as it is computationally complex from the point of view of implementation.

BLOOD SPATTER ANALYSIS:

In [9] the authors basically describe how the 3D scanning technology is used to record crime scenes. For this purpose 3D scanners such as HEMOSPAT and FARO 3D scanners are used to analyze the impact of stain pattern on different object and surface like floor, wall etc. the stains are photographed and then FARO laser scanner was used to collect data from the scene for later analysis of the spatter pattern. These scanners uses the principle of BackTrack™ to determine an approximate area of origin of the stains within a few cm of the actual source location. HEMOSPAT scanner gives near to the actual result. FARO provides more compatible and 3D result. The FARO data collection proceeded very quickly but the subsequent analysis is quite involved. The HemoSpat scanner is much less expensive than 3D scanning equipment. Also, as the present results indicate, it is easy for "first-time users".

Although the FARO results corresponded well to the HemoSpat results, the instrument is expensive and the training required to use it is not trivial. However, if the instrument is already available, and an experienced analyst is present, the use of FARO technology would rival the use of a program like HemoSpat. An experienced FARO operator can conclude an analysis in a short period of time and it could be accomplished easily by an investigator working alone.

In [10] the authors have described how the automatic technology for calculating the impact angle of spatter is advantageous of native string method which took lot of time and effort but produced near to approximate result. Now commercial software has been developed to compute both impact angle and major axis angle, after a user clicks digital images of the spatter pattern in the crime scene. The image processing techniques in MATLAB are used to analyze the pattern of different types of stain. We hypothesise that computer vision could help automate and quantify the reliability of blood spatter analysis. The image of blood spatter is the combination of primary and non-primary patterns, so ellipse fitting technique can be unreliable when non-primary spatter patterns dominate as ellipse fitting technique is

very robust method for calculating impact angle. Images are photographed and homography calibration is used to rectify different parts of same crime scene. Since the blood is not uniform as blood is a mixture of lighter plasma proteins and red blood cells. These blood dynamics lead to confusion on the relationship between velocity and the size of the drops, hence the result produced by image processing can lead to unreliable result. These factors are considered by forensics experts and they are trying to work with this in near future by finding some solutions to it.

The authors have prescribed in [11] the quantitative analysis of high blood stain pattern by image processing. The journal specifies how to differentiate between high velocity, medium velocity and low velocity blood stain pattern generated by different object. High velocity spatter is basically due to gunshot, medium velocity spatter is the impact of hit by blunt objects and low velocity spatter are passive blood stains caused by cut by a knife. There had been a method to establish an image analysis methodology that yields hard data about bloodstain patterns. The image analysis methodology presented in the journal provides an objective and rigorous means of quantifying the size and spatial characteristics of a spatter pattern. The paper emphasizes that after the high-resolution photographs of the bloodstain are digitally stitched together, the software takes just a few seconds to automatically calculate the size and position of the many thousands of droplets present in a spatter pattern. Bloodstain patterns generated at actual crime scenes will likely have many complicating factors, including obstruction by clothing or other objects, superposition of multiple spattering events, and complications due to spatter landing on fabric or other non-uniform surfaces. These aspects, and their influence on the resulting spatter patterns, need further study.

Kittipat et. al. in [12] examines the work developed by simple image processing method for calculating impact angle of stain. The simple computer application consumes minimal time and provides user friendly interface. The bloodstain from the impact of blood droplets on a surface is caused by inertia. When a blood droplet lands on a surface, the inertia of the blood keeps the mass moving along the same path creating a pattern that can be elliptical or circular depending on the angle of impact of stain on the surface. After, the bloodstain was digitally photographed with a marker perpendicular to the ground; then some steps are required for the calculation. After the image is uploaded in the program, the blood color identification can be done. The preset values in the program were used to identify the blood in the image. All the colors except blood color were then marked black. The marker assists the program to rectify the dimension of the blood when it is uploaded. It is always affixed perpendicular to the ground and by the side of the stain. From the original image, the program locates the marker by selecting the color of the marker and sets other remaining images to white. The remaining color, i.e. marker, was then measured for the size and converted into the dimensions of width and length from pixels to millimeters. After that major axis angle and impact angle was calculated.

The results from image processing technique using some bloodstains on minimum pixel value that is having white background indicated that average %-error of all parameters with an automatic processing is not very much acceptable. However, the overall results of from the manual process showed better results. Therefore, the manual process that includes calculating impact angle by earlier used 'string method' is required if there is a concern for more accurate results.

CONCLUSION:

In this survey paper, we have discussed three image processing techniques namely, near duplicate image detection, histogram based contrast enhancement and blood spattering. The main disadvantage we encountered in paper some of the above papers is the speed which is not appropriate for handling large data of identical pairs. To improve this we can use bag of words technique in the case of filtering the data and matching of data pairs. The main disadvantage of one of the papers is that it is greatly affected by the small changes between the identical regions. One reason for such variation is due the presence of excessive noise and compression which is lossy. The noise can be reduced by using various photoshops after acquiring the images. We can also use lossless compression file formats.

There may be certain images or videos captured by surveillance cameras or cameras used in crime scene investigation which due to certain external factors like poor lighting, etc. or due to the inexpertise of the photographer might get blurred or unclear. Such images which might contain vital details or information about a crime would need to be recovered. Such images can be improved and their details can be recovered by using contrast enhancement. In some papers we have a computationally complex algorithm and one has an increased cost due to the use of masks. To overcome this we can use a modified local histogram equalization method.

Then, we have also discussed about blood spattering which is a new and emerging image processing technique which is used in the investigation of forensics of crime investigation. Here the droplets of blood that have dropped from a higher surface onto a lower surface, are used for investigation. These droplets might be those of the victim who might have been murdered. Such blood spatters are used to detect the instrument used for the crime or the direction or height from which the blood has hit the surface. Such information help the investigators to reconstruct the scene as to what might have happened and give a clue to the crime.

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